

Lichens of the Imperial Palace Grounds, Tokyo. I. *Chrysothrix flavovirens* New to Japan

Hiroyuki KASHIWADANI^a and Göran THOR^b

^aDepartment of Botany, National Science Museum, 4-1-1 Amakubo, Tsukuba, Ibaraki, 305 JAPAN;

^bSection for Conservation Botany, Department of Ecology and Environmental Research,
Swedish University of Agricultural Sciences, P. O. Box 7072, S-750 07 Uppsala, SWEDEN

(Received on June 20, 1996)

The lichen *Chrysothrix flavovirens* is reported as new to Japan, based on a recent collection in the Imperial Palace Grounds in Tokyo. Further records are also reported, based on earlier collections from Aki and Suo Provinces. The species was previously known only from Europe.

As part of a biological investigation of the Imperial Palace Grounds in Tokyo, the authors were permitted to collect lichens here in one day in 1995. The results of our collections will be published in a series of papers of which this is the first. There are no previous lichen collections from the Imperial Palace Grounds, and no earlier publication about the lichens for the area. In spite of earlier skirmishes, earthquakes and frequent fires in Tokyo as well as the World War II, parts of the palace remain surprisingly intact over a period of several centuries. Lichen rich substrates include old stone walls, alley trees, rocks (from dry and exposed to shaded at streams and ponds) and oldgrowth forests. The investigation will officially begin in 1996; the results reported in the present are based on a preliminary survey in 1995. The genus *Chrysothrix* was first reported from Japan by Kashiwadani and Thor (1995) with one species, *C. candelaris*. Studies of the material from the Imperial Palace Grounds revealed one further species, *C. flavovirens*. Some further collections were found when going through material collected by one of the authors (GT) during a field trip in

1995.

The Imperial Palace Grounds

The Imperial Palace Grounds is located in downtown Tokyo ca. 2 km apart from the mouth of the Sumida-gawa River at Tokyo-wan Bay. The present palace was completed in 1968, the previous Meiji Imperial Palace having fallen victim to bombing in the World War II. Prior to the construction of the Meiji Imperial Palace during the Meiji Restoration of 1868–1912, the site was occupied by the Edo-jo Castle. This castle was in its time the largest in the world and covered a larger area than the present, but apart from portions of the moat and some stone walls, little remains to mark its former existence.

The altitude varies from 4 m in the moat surrounding the palace to 29 m on a small hill, and the location is 35°41'N, 139°45'E. The palace consists of an outer portion which is open to the public (e.g., the East Garden = Higashi-Gyoen), and an inner which is generally closed to the public. The inner portion covers 115 ha and was searched during the present investigation. The outer portion was

not studied. Collecting was permitted in all habitats except on bonsai trees, to which both lichens and mosses are considered to contribute aesthetic appeal. Both crustose lichens and *Cladonia* occur on the bonsai trees.

The administration and official buildings of the palace are located in a small area in the eastern portion. Elsewhere, scattered buildings, forests, grasslands, alleys, stone walls, ponds and small gravel roads are to be found. Apart from the moat surrounding the Imperial Palace Grounds, scattered ponds are present within the palace (most of them part of an old moat), providing a rather high and stable humidity. Temperate deciduous forests are found on nutrient-rich soils (e.g., in the Fukiagegyoen palace garden), and open mixed deciduous/coniferous forests with *Pinus thunbergii* occur on drier nutrient-poor soils. The temperate deciduous forests may be classified as oldgrowth and consist in part of *Castanopsis cuspidata*, *Cyclobalanopsis acuta*, *Ilex integra* and *Machilus thunbergii*. These forests contain considerable amount of dead wood (snags, logs, stumps), a substrate scarce in modern commercial forests. Forests with a long environmental continuity are at present very rare in the Musashino plain where Tokyo is located. There are several old stone walls, constructed mainly for defense. Some saxicolous lichens are almost certainly strongly correlated with the occurrence of unrestored (or sensitively restored) stone walls, several hundreds of years old. Further investigations and comparisons with more recent stone walls would help to clarify such relationship. An enumeration of pteridophyta and spermatophyta has been published by the Biological Laboratory, Imperial Household (1989).

Climate

The annual mean temperature in Tokyo is 19.5°C with the coldest month in January (mean temperature 9.5°C) and the warmest

month in August (mean temperature 30.9°C) (National Astronomical Observatory 1994). The annual mean precipitation is 1405 mm of which 45 mm falls in January (the driest month), and 185 mm in June (the wettest month) (National Astronomical Observatory 1994). Snow falls as an average of 11 days during the winter (National Astronomical Observatory 1994), but usually melts quickly. All values are mean values for the period 1961–1990.

Methods

Light microscopy measurements were made with an oil-immersion lens on water mounts, achieving a precision of 1 μm . The iodine colouration (Lugol's solution; iodine concentration 0.25%) was studied both with and without pretreatment with K; the former colouration here denoted the K/I colouration, the latter the I colouration. The values of the measurements represent the extreme range. Calcium oxalate was searched for under the microscope by adding 25% H_2SO_4 (sulphuric acid) under the cover-slip, thus causing the crystals to dissolve and recrystallize as needle-shaped crystals of calcium sulphate. Thin layer chromatography (TLC) was carried out in accordance with the method described by White and James (1985). Only the B system (HEF) was used. The morphological description is based on the Japanese material.

Results and Discussions

Chrysothrix flavovirens Tønsberg

Thallus episubstratal, without calcium oxalate; photobiont Chlorococcales, cells 7–14 μm in diameter; hyphae 2–3 μm wide; soralia forming a \pm coherent leprose layer, pale greenish yellow to rarely yellowish green; soredia 14–24 μm in diameter. Apothecia not seen. Pycnidia not seen. Chemistry: Rhizocarpic acid (TLC); thallus K-, C-, PD-, I-, K/I-, UV+ orange.

Notes. *Chrysothrix flavovirens* was recently described as the sorediate counterpart of *C. chrysophthalma* (Tønsberg 1994). For detailed descriptions of the species, see Laundon (1981) and Tønsberg (1992). *Chrysothrix flavovirens* is characterized by the presence of a sorediate, usually pale greenish yellow thallus yielding rhizocarpic acid. *Chrysothrix candelaris* is similar, but is usually more bright yellow and has calycin, pinastric acid or calycin and pinastric acid. The thallus morphology of the Japanese and European material is identical. While the European collections have “chrysophthalma unknown” in addition to rhizocarpic acid (Tønsberg 1992), the Japanese collections have rhizocarpic acid only. This chemical discrepancy is in our opinion insufficient to warrant separate taxonomic status. Corticolous specimens of the typically saxicolous *Psilolechia lucida* are similar in thallus morphology and also contain rhizocarpic acid, but also produce traces of four unidentified substances (TDA) or zeorin (Coppins and Purvis 1987). Corticolous specimens of *Psilolechia lucida* also lack true soredia, and are found in more sheltered and shaded habitats than *C. flavovirens* (cf., Coppins and Purvis 1987, Tønsberg 1992). The collection of *C. flavovirens* from the Imperial Palace differs from the other Japanese collections by having a yellowish green colour (an artefact of air pollution?). The coelomycete *Minutophoma chrysophthalmae* D. Hawksw. which is reported only from *Chrysothrix chrysophthalma* (Hawksworth 1981) and *C. flavovirens* (Santesson 1993, as *C. chrysophthalma*) in Europe was searched for but not found.

Habitat. *Chrysothrix flavovirens* was found within the Imperial Palace Grounds in a rather open oldgrowth deciduous forest at the base of an old *Ilex integra* at the small house Sohikintei near a pond. In Miya-jima and Iwakuni, both in the southwest part of Honshu,

it was collected on stumps in open oldgrowth deciduous forests (G. Thor 12819, 12834), at the base of a dead *Pinus* sp. at the sea-shore (G. Thor 12811), and on the bark of a large tree in a park (G. Thor 12845). All localities are located within a few kilometres of the sea. The Swedish material is restricted to similar habitats and localities. Most of Miya-jima is included in a National Park, and the forest at Iwakuni is also protected.

Distribution. *Chrysothrix flavovirens* has previously been reported only from Europe where it occurs in lowland, mainly coastal sites in the British Isles, Estonia, Norway, Spain and Sweden (e.g., Tønsberg 1992, 1994 and further references here). In Japan it was found at scattered localities along the east coast of Honshu from Musashi Province in the north to Suo Province in the south. The widely separated localities in Japan might indicate that further localities are present in coastal areas of Honshu. The species was found at three localities on the island Miya-jima and at one locality in Iwakuni. It was searched for in Shikoku around the cities Matsuyama and Uwajima, and along the coast from Uwajima down to Cape Ashizuri-misaki.

Specimens examined. Honshu, Musashi Prov. (Tokyo-to = Tokyo Metropolis), Chiyoda-ku, the Imperial Palace Grounds, Fukiage-gyoen palace garden around the small house Sohikintei, 35°41'N, 139°45'E, alt. 22 m, 20 June 1995, G. Thor 14892 (TNS); Aki Prov. (Hiroshima Pref.), Saiki-gun, Miyajima-cho, 20 km SW of Hiroshima, the island Miya-jima (Itsuku-shima), the W to N slope of Mt. Misen from the ropeway station Shishiwa and along the trail to Omoto Park, 34°17'N, 132°19'E, alt. 200–500 m, 25 January 1995, G. Thor 12819 (TNS); do., 1200 m SW of the ferry terminal, Omoto Park, 34°17'N, 132°19'E, alt. 10–40 m, 27 January 1995, G. Thor 12845 (TNS, herb. G. Thor); do., 4 km SW of the ferry terminal, the sea-shore at the station of Miya-jima Natural Botanical Garden, 34°17'N, 132°17'E, alt. 2–5 m, 25 January 1995, G. Thor 12811 (TNS, herb. G. Thor); Suo Prov. (Yamaguchi Pref.), Iwakuni city administrative area, 36 km SW of Hiroshima, Iwakuni, along the trail on the SE slope of Mt. Shiro from Iwakuni

castle to the base of the ropeway, 34°10'N, 132°19'E, alt. 20–200 m, 26 January 1995, G. Thor 12834 (TNS, herb. G. Thor).

The staff at the Imperial Palace Grounds are thanked for guiding us during our field work. L. Rundgren and A. Telenius are thanked by GT for companionship during the field trip in the Hiroshima area. Prof. T. Seki is thanked for guiding us on Miya-jima and in Iwakuni, and all other staff at the Miya-jima Natural Botanical Garden field station are also thanked for their hospitality. We are also grateful to T. Goward for improvement of the English style. Financial support for field work in the Hiroshima area by GT was provided by a grant-in-Aid for Scientific Research from the Ministry of Education, Science, Sports and Culture (No. 94150), the Scandinavia-Japan Sasakawa Foundation and the Uddenberg-Nordingska Foundation. Financial support for HK was provided by a grant-in-Aid for Scientific Research from the Ministry of Education, Sci-

ence, Sports and Culture (No. 7640945). The stay in Japan for GT was granted by a post-doctoral fellowship and a fellowship for Priority area research in Japan, both from the Japan Society for the Promotion of Science (JSPS).

References

- Biological Laboratory, Imperial Household (ed) 1986. Flora sedis imperatoris Japoniae. 1–546 pp. Hoikusha, Osaka.
- Coppins B. J. and Purvis O. W. 1987. A review of *Psilolechia*. Lichenologist **19**: 29–42.
- Hawksworth D. L. 1981. The lichenicolous Coelomycetes. Bull. Br. Mus. nat. Hist. (Bot.) **9**: 1–98.
- Kashiwadani H. and Thor G. 1995. Northern circumpolar crustose lichens new to Japan. J. Jpn. Bot. **70**: 303–321.
- Laundon J. R. 1981. The species of *Chrysothrix*. Lichenologist **13**: 101–121.
- National Astronomical Observatory 1994. Chronological Scientific Tables. Maruzen Co., Tokyo (In Japanese).
- Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. SBT-förlaget, Lund.
- Tønsberg T. 1992. The sorediate and isidiate, corticolous, crustose lichens in Norway. Sommerfeltia **14**: 1–331.
- 1994. *Chrysothrix flavovirens* sp. nov. – the sorediate counterpart of *C. chrysophthalma*. Graphis Scripta **6**: 31–33.
- White F. J. and James P. W. 1985. A new guide to microchemical techniques for the identification of lichen substances. Br. Lich. Soc. Bull. **57** (Suppl.): 1–41.

柏谷博之^a, ヨーラン・トール^b: 皇居の地衣類 I. 日本新産のコガネワタゲゴケ

1995年に実施された皇居の地衣類予備調査において *Chrysothrix flavovirens* Tønsberg (コガネワタゲゴケ, 新称) が発見された。本種はこれまでに欧州のみに分布することが知られていたが^a, 本邦にも産することが明らかになった。本種は *C. candelaris* (L.) Laundon に酷似するが^a, 地衣体が淡黄緑色でリゾカルプ酸を含むので区別できる。日本産の標本は形態的には欧州産のものに一致する

が^a, “*chrysophthalma* unknown” (Tønsberg 1992) を含まない化学的変異株と考えられる。皇居内ではやや日当たりの良いモチノキの樹皮上で見つかったが^a, この他にも、広島県宮島、山口県岩国市の標本4点も本種と同定された。

(^a 国立科学博物館植物研究部,
^b スウェーデン国立農科大学)